An experimental test of a game-theoretical model of reciprocity.

Gallucci, M.; Perugini, M.

published in
Journal of Behavioral Decision Making
2000

DOI (link to publisher)
10.1002/1099-0771(200010/12)13:4<367::AID-BDM357>3.0.CO;2-9

document version
Publisher's PDF, also known as Version of record

Journal of Behavioral Decision Making
J. Behav. Dec. Making, **13**: 367–389 (2000)

An Experimental Test of a Game-Theoretical Model of Reciprocity

MARCELLO GALLUCCI[1] and MARCO PERUGINI[2]*
[1]*University of Rome, 'La Sapienza', Italy*
[2]*University of Leicester, UK*

ABSTRACT

In this contribution the norm of reciprocity is defined as a basic internal motivation. Using formal tools of game theory, a model of social utility function is presented. The reciprocity model predicts that social actors should reciprocate costs and benefits they receive, even when there are costs in conforming to the norm. Hypotheses about actors' behavior, expectations and evaluations are derived from the model. The hypotheses were tested in an experimental situation, the reciprocity game, consisting of a prisoner's dilemma game (PD) followed by a dictator game (DG). The sample was composed of 74 Italian undergraduate students. In line with the model's predictions, the experimental results showed that participants reciprocate the behavior of the opponent in the PD. In the DG, if the opponent cooperated, participants gave back an almost equal share, whereas if the opponent defected, participants gave a minimal amount. These reciprocity effects are modulated by individual differences in the concern for reciprocity. Copyright © 2000 John Wiley & Sons, Ltd.

KEY WORDS game theory; social utility; reciprocity; individual differences

Social psychologists have often advocated that individuals in situations of interdependence of outcomes are concerned with both their outcomes and the outcomes of others. Researchers have pointed at the necessity to define motivational functions, i.e. utility functions, tapping the basic concern about the other's outcomes (e.g. Conrath and Deci, 1969; Loewenstein *et al.*, 1989; McClintock and Liebrand, 1988; Messick and McClintock, 1968; Messick and Sentis, 1985; Wyer, 1969). The situation is different in the field of economics. Mainstream economics is still reluctant to adopt concern for others' outcomes as a motivational source for individuals engaged in economic transactions. Only in this last decade has this position started to be adopted by economists. Some experimental economists have recognized that the experimental results in social dilemma and bargaining situations cannot be fully accounted for by using exclusively the assumption of personal outcome maximization (e.g. Dawes and Thaler, 1988; Guth and Tiez, 1990), and have suggested the importance of incorporating the other's outcome into individual preferences (Bolton, 1991; Bolton and Ockenfels, 1999; Fehr and Schmidt, 1999; Rabin, 1993).

* Correspondence to: Marco Perugini, Department of Psychology, University of Leicester, University Road, Leicester LE1 7RH, UK. E-mail: mp57@le.ac.uk

 Accepted 11 August 1999

Social psychology and economics are therefore starting to converge towards a basic approach of encoding interpersonal preferences using *social utility* functions. Social utility functions specify levels of satisfaction as a function of the outcomes to self and other (Loewenstein *et al.*, 1989). Among the different self–other outcome combinations that have been studied (e.g. MacCrimmon and Messick, 1976), a basic model of social utility has gathered consensus in both social psychology and experimental economics (cf. Blount, 1995). The model focuses on two specific sources of utility: the personal material outcome (i.e. the payoff to self), and the comparison between the personal outcome and the other's outcome. All these models generally try to implement the motivation to achieve fair outcomes, assuming that individuals perform a sort of mental calculation of difference between their payoff and the others' payoff and choose the behavior which minimizes such a difference.

Notwithstanding the importance of equality in influencing economic behavior, both theoretical considerations and empirical results suggest that other social mechanisms can have a pivotal role in interpersonal exchanges. Indeed, modeling the motivation to achieve fair comparisons exclusively as a difference among payoffs implies that the interpersonal preferences over the outcomes are only incidentally related with the other's behavior. In other words, if an individual is striving only to minimize the difference of outcomes (cf. Adams, 1965; Loewenstein *et al.*, 1989), her or his behavior will be the same irrespective of whether the distribution of outcomes depends on the actions of other actors, if the intentions of the others are positive or negative, or whether the distribution depends on external factors out of the actors' control.

Some experimental results do not support this view. For instance, Blount (1995) was able to generate different rejection rates in the ultimatum game as a function of the perceived intentionality of the proposer. This result is in line with early results of Leventhal *et al.* (1969) who showed that individuals are more concerned about the comparison between outcomes when reacting to another person's proposal than when reacting to a random distribution of payoff. The importance of the other's behavior has been studied also in more complex settings. For instance, it has been shown that proposals in multi-stage bargaining vary as a function of previous proposals by the other bargainer, such that concessions are matched both in frequency (Komorita and Esser, 1975) and in value (Esser and Komorita, 1975), and that consumption in a resource dilemma is higher when scarcity is caused by other participants in the experiment than when it is due to environmental reasons (Rutte *et al.*, 1987). These results highlight the importance of evaluating others' perceived behavior in determining a player's behavior, and suggest that merely considering the differences in the outcomes may not be appropriate in certain conditions.

RECIPROCITY

Reciprocity has been used in the social psychological literature to explain a wide range of behavior, such as gift giving (Cialdini, 1988), attitude change (Cialdini *et al.*, 1992), intimacy in close relationships (Surra and Longstreth, 1990), altruism (Krebs, 1975), and cooperation (Komorita *et al.*, 1991, 1992; Liebrand *et al.*, 1986). One of the first definitions of reciprocity was provided by social exchange theory (Blau, 1964; Gouldner, 1960; Thibaut and Kelley, 1959): the norm of reciprocity prescribes that individuals should help who helped them and should retaliate against those who hurt them. Several studies have been conducted to investigate the role of reciprocity in situations of interdependence of outcomes. In social dilemmas, individuals show the tendency to reciprocate both previous cooperation (reward) and defection (punishment) (Komorita *et al.*, 1991, 1992). In bargaining situations concessions are often reciprocated (Benton *et al.*, 1972; Komorita and Esser, 1975) even when the strategic aspect of the interaction has minimal impact (e.g. no expectation of future interactions, Berg *et al.*, 1995). Moreover, reciprocations of the other's strategy is present both when the other's strategy is observed or only anticipated (Liebrand *et al.*, 1986; Wilke and Braspenning, 1989). In accordance with these results, we assume that when individuals interact after observing the other's behavior they will react to that behavior, whereas when the behaviors are simultaneous, the reactions will refer to the expectations about the other's behavior. Therefore, we define the reciprocity norm as prescribing individuals to reward (help) those who have rewarded (helped) or are expected to reward (help) them and to punish (hurt) those who have punished (hurt) or are expected to punish (hurt) them.

THE RECIPROCITY MODEL

The reciprocity model has two main distinguishing features: (1) the approach used to derive predictions and (2) the specific utility function.

Formal approach

The first characteristic of the present work is the formal approach we use. We will briefly present here a theoretical model of reciprocity which is defined and analyzed in symbolic terms but which has a distinctive social psychological flavor (for a more detailed presentation, see Perugini and Gallucci, 1998). For this purpose we will use formal tools of game theory. Formal tools offered by game theory allow a full exploitation of the formalism of the model, since it is possible to derive logical implications and predictions working at a symbolic level. This approach is successfully used in the field of economics, and it provides an extremely powerful framework to incorporate psychological insights into a formal analysis (Bolton, 1991; Bolton and Ockenfels, 1999; Fehr and Schmidt, 1999; Geanakoplos *et al.*, 1989; Rabin, 1993). To our knowledge, this is the first attempt in current social psychology to use formally game theory to generate experimental hypotheses.

Usually, models in social psychology differ from models in economics as regards the formal tools used to elaborate the theories and to provide predictions. Whereas economic models are largely based on a symbolic and logical analysis of the implications of the assumptions (cf, Bolton, 1991; Kirchsteiger, 1994; Rabin, 1993), social psychological models mostly focus on the empirical estimation of the relevant parameters (cf. Loewenstein *et al.*, 1989; Messick and Sentis, 1985). These two approaches can be considered as falling in different points on a continuum of specificity versus generalizability. A theoretical model should be generalizable whereas an empirical model, which may also be an empirical version of the theoretical model, should be specific. Empirical models are generally more accurate in reflecting the psychological processes but are often difficult to apply to general classes of situations and they heavily depend on minor features influencing the specific parametric values. On the other hand, symbolic models can be used to study situations without an empirical estimation of the specific parameters. They involve assumptions and formal statements that can be logically (and mathematically) analyzed to provide predictions and to understand the phenomenon under study. Moreover, the implications of the symbolic analysis can be tested experimentally and therefore they can be validated from an empirical point of view.

Utility function

The second characteristic of our model is the assumption that individuals compare the utility derived from offering a given payoff to the other and the utility derived from having been offered, or expecting to be offered, a given payoff. This comparison implements the motivation to follow the norm of reciprocity. Thus, the model differs from other social utility function models since it incorporates the individual motivation to follow the norm of reciprocity rather than the motivation to achieve equal distributions or to avoid disadvantageous inequality. We further assume a heterogenic distribution of sensitivity to the norm of reciprocity, that is, we assume that the importance of the norm-related utility varies across individuals in a given situation.

Besides these distinguishing features, we follow the basic assumptions of the social utility approach (Loewenstein *et al.*, 1989; Messick and Sentis, 1985). We assume that the evaluation of the outcomes is a linear combination of two sources of utility, the utility associated with the personal material outcome (payoff to self), and the utility associated with the social norm.

The *generic* utility function[1] is defined as follows (for an even more general formulation, see Perugini and Gallucci, 1998). Considering two players, i and j, and denoting as π_i the self-interested material outcome of player i, ρ_j the value that player j offers or has offered to player i, ρ_i the value that player i offers or is going to offer to player j, λ_i the individual sensitivity to reciprocity of player i, and F a generic function, the generic utility function of player i is:

$$U_i(\pi_i, \rho_j, \rho_i) = \pi_i + \lambda_i F(\rho_j - \rho_i) \tag{1}$$

Assumptions of the model

We can now define better the basic assumptions underlying this utility function and consequently the reciprocity model.

(1) The overall utility associated with a certain behavior is given by a combination of the utility of the self-interested payoff (ρ_i) and the utility associated with following the norm of reciprocity ($\lambda_i F(\rho_j - \rho_i)$).
(2) The utility associated with following the norm of reciprocity is represented by a generic function F, which must have its maximum for $\rho_j = \rho_i$ and it must decrease as the difference between ρ_j and ρ_i increases. Any function having these properties will implement the notion that the more (less) one receives by the other the more (less) one has to give back (cf. Exhibit 1). For the sake of mathematical elegance and tractability, in the present work we will use a quadratic (i.e. convex) function:[2] $F(\rho_j - \rho_i) = -(\rho_j - \rho_i)^2$.
(3) According to the definition of reciprocity, we assume that the value of the received behavior (ρ_i) is dependent on the behavior of the other agent in the interaction and it represents what an individual would feel that the opponent has given to him or her. It is a function of the outcome and also of the intentionality of the opponent's behavior. The value of the addressed behavior (ρ_j) is dependent on the expected effects of a given behavior on the opponent and it represents what an individual would feel that the opponent would value a given behavior. It is a function of the outcome for the opponent and of the expected impact on him or her. Maximizing the comparison function between these two values therefore represents a player's estimation of what the opponent deserves on the basis of what the player thinks the opponent did to him or her. It is clear then that individuals may evaluate differently the payoff they received or the payoff they are addressing depending on the structure of the game (cf. Thompson and Lowenstein, 1992), and that they can be sensitive to even seemingly very minor variations in the structure (cf. Larrick and Blount, 1997). This assumption that the reciprocal reaction is based on the *subjective* value of the behaviors (ρ's) and not simply the payoffs (π's) is crucial in differentiating the present model from other models presented in the literature. In fact, as far as one does not equate ρ_i to the payoff of player i, the model gives unique predictions in several situations. On the other hand, by equating ρ_i to the payoff of player i, the

[1] See equation (2) for the *specific* utility function which we will use in this contribution.
[2] The choice of any other specific function meeting the specified basic requirements would not affect our analyses and predictions in this contribution (cf. Appendix 1).

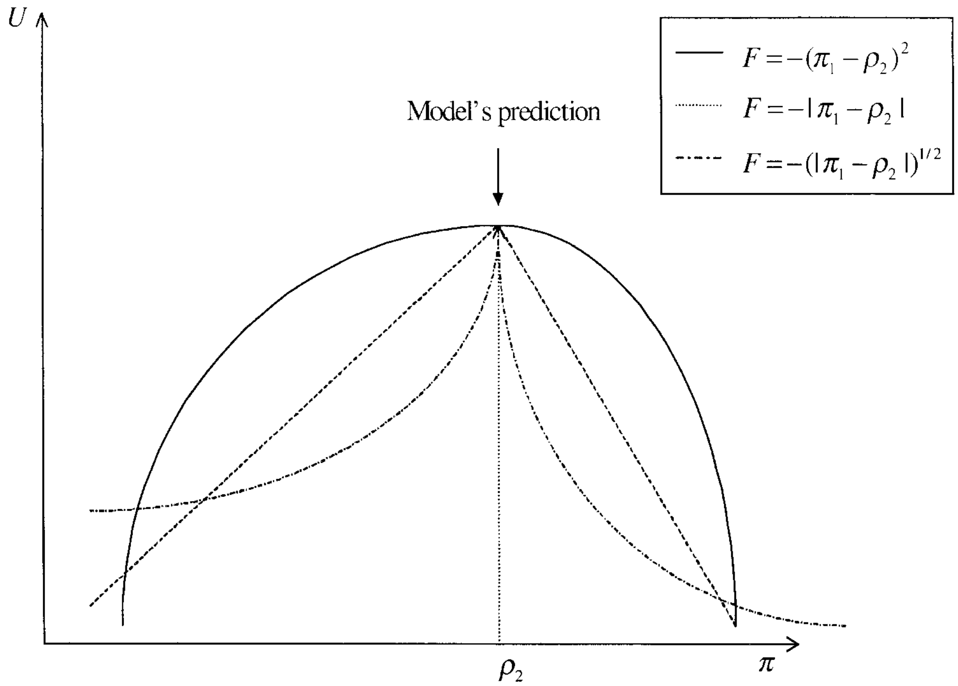

Exhibit 1. Equivalence of predictions for different forms of *F*. *Note*: The graph represents the utility (U) associated with any possible strategy (π_1) in a DG given a certain ρ_2 and λ_1. The curves represent three different utility functions $F(\pi_1 - \rho_2)$: convex, linear and concave

present model would implement concern for equality (cf. Bolton, 1991; Conrath and Deci, 1969; Fehr and Schmidt, 1999; Loewenstein *et al.*, 1989; Messick and Sentis, 1985). In symmetric games like social dilemma, these values may be simply equal to the payoffs one expects from the strategy of the other and the payoffs one is addressing to the other. Indeed, in symmetric games reciprocating the outcomes is formally and logically equivalent to reciprocating the other's behavior. For the symbolic analysis we will perform here it is *sufficient* to estimate whether the values of the received and of the addressed behavior are positive or negative.

(4) We assume that the lambda parameter (λ_i) represents the importance given to reciprocity by an individual. In other terms, the more a person is sensitive to reciprocity when he or she is making a decision, the higher lambda will be. The higher lambda is, the more the overall utility depends on the utility associated with reciprocity, whereas the lower lambda is, the more the material self-interested payoff is important. Lambda may be influenced by several factors, both individual and situational. It may vary across situations depending on social and structural aspects that increase the salience and the importance of reciprocity. It may vary across individuals as a function of individual differences. In spite of the theoretical generality of the parameter, the model requires only that lambda is positive and it has a distribution in the population such that different individuals are differentially sensitive to reciprocity.

(5) In performing a formal analysis using the model, we assume that individuals choose the strategy maximizing their utility, depending on their expectations about the opponent's strategy. Thus, if player i expects that the opponent will play s_j, he or she will play a strategy s_i^* such that no other strategy will give him or her a higher utility. We will call the strategy s_i^* the best reply to s_j (cf. Fudenberg and Tirole, 1991). Thus, in simultaneous games, it is assumed that the player

reciprocates the behavior he or she expects from the other, whereas in sequential games the model assumes that the other's behavior in the previous branch of the game is reciprocated. Note that these assumptions imply a full pattern of reciprocity. In fact, when the game involves both simultaneous and sequential moves, it is assumed that the player will reciprocate both the expected and the actual behavior.

Based on these general assumptions, the reciprocity model can be applied to several games (cf. Perugini and Gallucci, 1998). In this contribution we apply the model to a game which has been planned to test some of its implications and to analyze some unconfounded effects of reciprocity.

THE RECIPROCITY GAME

A situation that would allow a clean test of the norm of reciprocity should have some basic properties. First, the actors should interact such that they create a history. Second, the history should allow for positive and negative consequences. Third, the history should be of minimal length such that the strategic aspect has minimal impact, in that there are no expectations of future interactions. Finally, the predictions of the model concerning the behavior of the actors should be clearly distinguishable from alternative explanations.

The following situation is proposed to satisfy these requirements. The game involves two players,[3] player 1 and player 2, and has two stages. In the first stage the players play a simultaneous Prisoner's Dilemma game (PD; see Silverstein *et al.*, 1998), whereas in the second stage they observe the opponent's strategy. Then player 1 receives an endowment payoff, and she has to decide how to divide the payoff with the opponent. Player 1 can freely decide about any allocation, whereas player 2 can only accept the decision. This second stage is a Dictator Game (DG) with a history defined by the outcomes of the PD. In applying the model to this game, we simplify $\rho_j = \pi_j$. In fact, the amount of payoff proposed by the dictator for the second player is the only effective possibility for player 1 to affect the utility of player 2, given the structure of the game. Hereinafter we will refer to π_j instead of ρ_j, in order to avoid confusion with ρ_i.

We use therefore the following specification of the utility function:

$$U_i(\pi_i, \pi_j, \rho_i) = \pi_j - \lambda_i(\pi_j - \rho_i)^2 \tag{2}$$

The first stage is a PD with payoffs reported in Exhibit 2(a). As we argued above, in symmetric games like the PD $\rho_j = \pi_j$ and $\rho_i = \pi_i$. The utility values derived from the utility function (2) are reported in Exhibit 2(b).

In the second stage player 1 received an endowment $Q = 25$, and she must decide to give an amount d to the opponent, ranging from 0 to 25. The payoff of player 1 is $\pi_1 = 25 - d$ and the payoff of player 2 is $\pi_2 = d$. To define the utility function of player 1 for the second stage, we assume that the value of the received behavior is positive if the opponent cooperated in the PDG and negative if the opponent defected. Formally, we define the value of the received behavior as $\rho_c > 0$ if the opponent cooperated, and as $\rho_d < 0$ if the opponent defected. Therefore, the utility function for player 1 in the dictator game will be:

$$U_1 = 25 - d - \lambda_i(d - \rho_s)^2 \tag{3}$$

where s and c (cooperation) or d (defection).

[3] Hereinafter we will refer to player 1 as she and player 2 as he.

Exhibit 2. Payoff and utility matrix for prisoner's dilemma game

	D	C
(a) Payoff matrix		
D	15,15	25,10
C	10,25	20,20
(b) Utility matrix		
D	15,15	$(25 - \lambda_1 225), (10 - \lambda_2 225)$
C	$(10 - \lambda_1 225), (25 - \lambda_2 225)$	20,20

Note. C = cooperate, D = defect. For each cell the first value is the payoff for player 1 and the second is the payoff for player 2. λ_1 and λ_2 are the individual parameters of players 1 and 2, respectively.

HYPOTHESES

In this section we derive a set of experimental hypotheses regarding the PD and the DG. As regards the PD, we derive a set of hypotheses regarding the strategy choices as a function of the player's lambda, of expectations about and the evaluation of opponent's behavior. As regards the DG, we derive a set of hypotheses about the behavior of the dictators as a function of the dictators' lambda, their opponent choice in the PD, and their own strategy in the PD.

Consider the PD reported in Exhibit 2(a) and the corresponding utility values of the strategy combinations in Exhibit 2(b). Note that defection is always the best reply to defection, for any possible value of lambda. In fact, $U_1(D, D) = 15$ is always greater than $U_1(C, D) = 10 - \lambda_1 225$ for any $\lambda_1 \geqslant 0$. Thus, defection is clearly compatible with the model. On the other hand, cooperation is the best reply to cooperation whenever $U_1(C, C) \geqslant U_1\ (D, C)$, that is, when $20 \geqslant 25 - \lambda_1(25 - 225)$. Since there is a value of lambda $\lambda^* > 0$ such that cooperation can be the best reply to cooperation, cooperation is compatible with the model. Therefore, the model predicts that if $\lambda_i > \lambda^*$ and the player expects cooperation, the player will cooperate. From this reasoning it follows that the expectation of cooperation and a lambda greater than λ^* are both necessary but not singularly sufficient conditions for cooperation. On the contrary, the expectation of defection and a lambda value less than λ^* are both sufficient and not singularly necessary conditions for defection. Note that we do not claim that every observable cooperating behavior has this characteristic. On the contrary, this formulation means that our model can predict *only* the behavior having this characteristic. Accordingly, we state the following hypotheses.

H1: The greater the expectation of the opponent's cooperation, the higher the likelihood that participants will cooperate.
H2: The greater the lambda, the higher the likelihood that participants will cooperate.
H3: The combination of high lambda and high expectation of cooperation produces the highest likelihood of cooperation.

An important feature of the model is that individuals evaluate their opponent's (expected) behavior before reacting to it. The model implies that players who play C should feel themselves better off when the opponent cooperates than players who play D. According to H2, players who cooperate must have a lambda greater than zero, and thus the opponent's cooperation gives more utility to them than to defecting players, irrespective of the value of lambda. Formally, for cooperating players, the cooperation of the opponent gives a utility of 20 and the defection a utility of $10 - \lambda_1 225$. Thus the net utility of the opponent's cooperation for cooperating players is $\Delta_c = 10 - \lambda_C 225$. For defecting players, the cooperation of the opponent gives a utility of $25 - \lambda_D 225$ and defection a utility of 15. Thus, the net utility of the opponent's cooperation is $\Delta_D = 10 - \lambda_D 225$. It follows that $\Delta_C > \Delta_D$ if $\lambda_C > 0$, that is, the advantage given by the opponent's cooperation is greater for cooperating players than for defecting players. Note that if the model were incorrect, players would evaluate the opponent's behavior only in terms of self-interested benefits. In this case they should evaluate cooperation and defection regardless of their own strategy. In fact, if player 1 plays D, the net self-interested benefit given by the opponent's cooperation is 10 (25 − 15). This benefit is the same when player 1 plays C (20 − 10). The difference is therefore due to the social-related part of the utility function. Consequently, we state the following hypothesis:[4]

H4: The evaluation of the opponent's cooperating behavior should be more positive for participants who play C than for participants who play D.

Consider now the DG. In the dictator game, player 1 (the dictator) will offer the amount of payoff that maximizes her utility function. Applying maximization tools to function (3), we obtain that the best strategy for player 1 is to offer a payoff d^* such that

$$d^* = \rho_s - \frac{1}{2\lambda_1} \tag{4}$$

When the opponent defected ($\rho_s < 0$), the best reply strategy is $d^* = 0$, since the maximum is always negative and therefore lower than the lower bound of possible offers. When the opponent cooperated ($\rho_s > 0$), the best strategy prescribes that player 1 will offer $d^* \geqslant 0$. In fact, if $\rho_s \leqslant 1/2\lambda_1$ the best reply is $d^* = 0$ and if $\rho_s > 1/2\lambda_1$ the best reply is $d^* > 0$. Therefore $d^* \geqslant 0$.

Comparing the two results, the amount of payoff the player is willing to give to the opponent is greater if the opponent cooperated in the PD than if the opponent defected. We state therefore the following hypothesis:

H5: Dictators will give more payoffs to the opponent who cooperated than to the opponent who defected in the PD.

Hypothesis 5 is concerned with the general effect of reciprocity. To deepen the analysis, note that the dictators' allocation is a function of both the opponent's choice and their own lambda, and thus their strategy should depend on their concern for reciprocity (lambda). Consider first dictators who faced cooperating opponents. The optimal strategy for these players is given by equation (4) with positive ρ_i. The amount of payoff given to the opponent will heavily depend on the value of λ. That is, the greater is λ the greater is the amount of payoff given to the opponent. Accordingly:

H6: The higher the dictator's lambda, the higher the payoff given to the opponent who cooperates.

Consider now a dictator facing an opponent who defected. In this case the dictator's optimal strategy is given by equation (4) with negative ρ_i, corresponding to a value lower than any feasible value in the dictator's strategy set, irrespective of the value of λ. Therefore, the game does not allow us to establish differences in the optimal strategies for dictators facing defecting opponents. However, the model can be equally helpful in deriving differences in dictators' behavior as a function of lambda. The model predicts the same strategy for both types of dictators, but this strategy gives different utilities for the two types. The utility of playing $d^* = 0$ is generally given by $U_1 = 25 - \lambda_1(0 - (\rho_D))^2$. Consider a

[4] Obviously, the implicit assumption in this hypothesis is that, on average, individuals judge more positively what is better for them (i.e. what is giving more utility).

possible deviation from the prediction of the model. Any deviation is more costly for dictators with high lambda than for dictators with low lambda. Formally, given a small deviation δ such that the dictator plays $d' = d^* \pm \delta$, since $d^* = 0$, $d' = +\delta$, the utilities will be

$$U_1 = 25 - \delta - \lambda_1(\delta + \rho_D)^2 \tag{7}$$

Function (7) decreases proportionally to the product $\lambda\,\delta$, showing that the greater is λ, the more costly is the deviation δ. This implies that we should find more homogeneity in the behaviors within dictators with high lambda than within dictators with low lambda. Therefore the variance within the group of high-lambda dictators should be smaller than the variance within the group of low-lambda dictators. Given the constraints of the game (any deviation from $d^* = 0$ can only be positive) the amount of payoff given to the opponent can only increase. It follows that low-lambda dictators should give, on average, a slightly greater amount of payoff to an opponent who defected than high-lambda dictators. Note that the difference in the average values of the two types of dictators is the consequence of different variances, which are in turn the consequences of the differences in the cost of deviating from the optimal behavior. This implies that our reasoning will be valid *only if* we find differences in variances *and* in average values. We state the following hypothesis:

H7: Considering the payoff given to the opponent who defected, dictators with high lambda should show a smaller variance and give a smaller value than dictators with low lambda.

Note that the pattern of means and variances predicted by H7 is a consequence both of the heterogeneity of the sensitivity to reciprocity and of the structure of the game. For consistency, the heterogeneity of the sensitivity to reciprocity should have the same effect for other groups also when the structure of the game does not constraint the behavior, which implies that the same prediction should hold for the variability of payoffs given to the opponent who cooperated. Therefore, we can state the following hypothesis:

H8: Considering the payoff given to the opponent who cooperated, dictators with high lambda should show a smaller variance than dictators with low lambda.

The previous hypotheses rely on the assumption that the individual parameter lambda can be measured directly. However, in many situations assessing individual differences can be difficult or even impossible. One of the advantages of using a formal model is that it allows deriving predictions about behavior without direct measures of individual parameters. We now derive hypotheses about the DG without using an empirical measure of lambda. The aim of the following analysis is twofold: (1) to show the consistency of the formal model across the PD and the DG choices and (2) to show the powerful applicability of the model to situations where individual measures are not available or even unnecessary.

The model provides a nice characterization of the players as a function of the strategy they choose in the PD. In fact, by H2, players who play C in the PD must have a λ greater than players who play D. By consistency, we should observe that players who cooperate should behave as hypothesized for players with high lambda, whereas players who defect should behave as hypothesized for players with low lambda. Thus, we can state the following additional hypotheses.

H9: Dictators who cooperated in the PD will give more payoffs to the cooperating opponent than dictators who defected.

H10: Considering the payoff given to the opponent who defected, dictators who played C in the PD should show a smaller variance and a smaller average value than dictators who played D.

H11: Considering the payoff given to the opponent who cooperated, dictators who played C in the PD should show a smaller variance than dictators who played D.

As an anonymous referee kindly suggested to us, the model predicts that the variance of payoff given to the opponent who cooperated by the defecting dictators should be due to two types of dictators. In fact, there should be the dictators who rate defection unfavorably, and who defected in the PD because of a low expectation of cooperation, and dictators who rate defection favorably and who defected because of their individualistic orientation. Accordingly, we should observe that among those dictators who defect because they expect defection and who then observe the opponent to cooperate, the ones who rate defection unfavorably should give a higher payoff as compared with dictators who rate defection favorably. By the same token, among dictators who defect in the PD because they expect defection,[5] the ones with higher lambda should give increased reward to the cooperating opponent as compared with dictators with low lambda. We do not state these reasonings as formal hypotheses because the small number of participants in the cells do not allow a sufficiently powerful statistical test. However, we will perform some pilot analyses to check whether the insightful hypotheses suggested by the referee are empirically confirmed.

Uniqueness of reciprocity

In this section we show that the distinctive theoretical features of our model lead to different empirical predictions in the reciprocity game, as compared with other models of social utility function (Loewenstein *et al.*, 1989; Messick and Sentis, 1985; Wyer, 1969).[6] Many of those models have been defined only for one-shot situations, and do not explicitly allow for modelling multi-stage situations. Thus, for the sake of the argument, we consider them as if they would be applicable to such situations, squeezing out predictions which have never been hypothesized by the authors, but which nonetheless are a logical consequence of their models.

To simplify the discussion, denote $M_{go}(S_i, S_j)$ the payoff given to player j in the DG by player i, given that player i played strategy S_i and player j played S_j in the PD. By combining the hypotheses about the DG, we obtain that our model predicts the following pattern: $M_{go}(C, D) < M_{go}(D, D) < M_{go}(D, C) < M_{go}(C, C)$. If we now assume that individuals are motivated by pure equality, we obtain that the payoff given to the opponent is a function of the equity of the PD outcomes. Accordingly, we should expect the following pattern: $M_{go}(C, D) < M_{go}(D, D) = M_{go}(C, C) < M_{go}(D, C)$. Note that this pattern is both quantitatively and qualitatively different from the previous one, for it implies that cooperation and defection can be rewarded in the same way. On the other hand, if one assumes that individuals react only to the payoff they receive, $M_{go}(C, D) < M_{go}(D, D) < M_{go}(C, C) < M_{go}(D, C)$ would be the predicted pattern, which differs from the proposed one for it implies that mutual cooperation is not the condition that leads to the highest fairness of allocation. Finally, none of the cited models have been used to predict behavioral variability, nor is it clear how this could be done.

To sum up, we can therefore formulate the following hypothesis.

H12: Considering the different combinations in the PD, the model of reciprocity predicts the following pattern in the DG: $M_{go}(C, D) < M_{go}(D, D) < M_{go}(D, C) < M_{go}(C, C)$.

[5] As the same referee suggested, focusing on the dictators who defected because they expected defection avoids taking into the account participants who probably mistake their choice (that is, participants who expect defection, rate unfavorably defection and have a high lambda but still cooperate). In fact, in the present experiment those experimental cells are almost empty.

[6] For a comparison with economists' models (i.e. Bolton, 1991; Bolton and Ockenfels, 1999; Fehr and Schmidt, 1999; Rabin, 1993) see Perugini and Gallucci (1999, unpublished manuscript).

THE EXPERIMENTAL STUDY

Method

Participants
The participants were 76 Italian undergraduate students with an average age of 22.88 years (S.D. = 2.52). Thirty-one were male and 40 female, and for five more participants, information on gender was missing. The participants originated from 17 different faculties and were contacted at the University of Rome campus. They were invited to participate in an experiment where they could earn some money.

Experimental procedure
The experiment consisted of three identical sessions with different participants on each. In the three sessions 28, 24, and 24 participants took part, respectively. Participants in each session were randomly divided into two groups and each group was assigned to a room. In each room, an experimenter informed them of the experimental procedure. It was explained that: (1) the experimental session consisted of two games (i.e. the PD and the DG) during which was possible to gain money; (2) each participant would be randomly matched with another participant in the other room, and the pairs would be the same in both games; (3) since each participant would only be identified by a secret code number, there was no possibility of learning the identity of the other participant, and this was true for both the participant and the experimenter; (4) since each participant would receive an envelope for the strategy form, every strategy choice would be unknown to the experimenter.

This procedure was followed to assure the participants of anonymity, both to other participants and to the experimenters. Since the focus was on the actions of the dictators in the DG, all participants were informed that they had been assigned to the room where an extra amount of payoff was to be divided (i.e. the dictator rooms). Thus each participant was led to believe that the other participant would only play the first game (i.e. the PD). They were informed that their final payoff in the experiment was the sum of the payoffs of the first and second game (i.e. PD and DG), but that only 15% of the participants would be paid, according to a lottery.

The participants received a large and a small envelope, a personal code number, a payoff matrix for the first game, and a form with the alternative 'cooperate'/'not cooperate'. Participants were asked to answer three questions about the strategies. This allowed participants to become familiar with the logic of the games and allowed us to ensure that they understood the game. The payoffs in the PD were C–C (Italian £20,000, £20,000), D–C (£25,000, £10,000), C–D (£10,000, £25,000), D–D (£15,000, £15,000). At the time of the experiment Italian £1000 was approximately equivalent to $0.60.

The participants ticked their chosen strategy for the first game, put the strategy form in the small envelope and then put the small envelope in the large envelope, adding their personal code number. The envelopes were collected by a second experimenter and handed over to a third experimenter who organized the exchange of the strategy forms. Before receiving the information about the strategy used by the opponent, the participants filled in a short questionnaire in which they evaluated the possible opponent's behavior and reported their expectations (first set of measurements). After some minutes each participant received a strategy form with the presumed choice made by his or her opponent. However, it was not the actual choice of their opponent but a strategy form with a prepared choice. Half of the participants were informed that the opponent did cooperate and the other half that the opponent did not cooperate. Such a manipulation was used to ensure an equal number of cooperating and defecting opponents, although we discovered later than this manipulation was not really necessary, since the choices in the PD were almost equally distributed. Following the observation of the opponents' strategies, the participants received a new form. On this form they wrote the amount of money they chose to give to the opponent, and the amount of money they chose to keep for themselves. They could divide Italian £25,000 in any way they wanted. At the end of the experiment participants filled in a questionnaire containing, among other items, social-demographic questions and social desirability scales (second set of measurements). The session ended with the debriefing of the participants. They were fully informed of the aims of the experiment and the manipulation of the opponent's strategies. The code numbers of 15% of the participants were then drawn from a lottery and paid. Indeed, we decided to pay the participants the total payoff of the DG (Italian £25,000), since there was no real opponent. In the PD, participants were paid as if the opponent would have cooperated. This was done to show them that the manipulation was not intended to decrease their payoffs.

Measurement instruments

In the experimental session two sets of measures were administered: the first after the PD and the second after the DG.

First set of measurements

As argued above, three crucial variables are involved in the hypotheses derived from the model: (1) concern for reciprocity (lambda); (2) expectations about the opponent's behavior and (3) evaluations of the opponent's possible strategies:

(1) To measure the concern of reciprocity (*lambda*) the participants were asked to evaluate the fact that a player uses the same strategy as the opponent and that a player is fair.[7] Both evaluations were made using a 7-point semantic differential with three pairs of adjectives: satisfactory/not satisfactory, good/bad, and pleasant/unpleasant. The resulting six items showed high internal consistency (Cronbach's Alpha of 0.82), and a clear uni-factorial structure (the first factor explains 54.2% of the variance) with factor loadings ranging from 0.77 to 0.65.

(2) Participants' expectations of cooperation were measured using a 7-step Likert-like scale (1 = not likely to cooperate, 7 = very likely to cooperate).

(3) The participants were asked to evaluate the opponent's cooperation and the opponent's defection. For each possible opponent's strategy the evaluation was made using a 7-point semantic differential with three pairs of adjectives: satisfactory/not satisfactory, good/bad, and pleasant/unpleasant. The three adjective pairs showed a high consistency both for the evaluation of cooperation (Cronbach's Alpha of 0.80) and for the evaluation of defection (Alpha of 0.93). We computed a score for the evaluation of cooperation summing up the three adjective pairs for cooperation and a score for the evaluation of defection summing up the three adjective pairs for defection. The correlation between the two evaluation scores was −0.32.

Second set of measurements

We measured various potentially confounding variables. This set includes (1) four short scales of social desirability, (2) social-economic status variables and some questions concerning the experiment.

(1) To control the participants' tendency to behave in a social desirable way, we considered four factors of social desirability, each measured by five items: *impression management*, *self-deception*, *cooperation-related social desirability*, and *general social desirability*. Ten items were selected from

[7] The specific items were: (1) 'How would you consider the fact that a person uses the same strategy as the other?' (2) 'How would you consider the fact that a person behaves fairly?' For each question the participants answer using bipolar scales.

the Balanced Inventory of Desirability Responding (Paulhus, 1990), five from the *impression management* scale and five from the *self-deception* scale. Five items were generated for this study to measure the general tendency to behave in a social desirable way, and five items were generated to measure the tendency to consider cooperation as socially desirable. These 20 items were tested in a preliminary study involving a different sample ($n = 221$). To check for the dimensionality of the scales, we separately factor-analyzed the 10 items from the Balanced Inventory of Desirable Responding and the 10 items generated for this study. In the first analysis two orthogonal factors were extracted, with two factors corresponding to the expected factors (*impression management* and *self-deception*). The two factors explained 39.7% of variance (23.5% the first and 16.1% the second) and factor loadings ranged from 0.77 to 0.58 for the first factor, and from 0.71 to 0.39 for the second. For the newly generated items, we extracted two obliquely rotated factors: the first was formed by items referring to the *cooperation-related social desirability*, explained 31.8% of variance and showed factor loadings ranging from 0.76 to 0.45. The second factor was formed by items, referring to the *general social desirability*, explained 17.1% of variance and showed factor loading ranging from 0.75 to 0.61. The correlation between the two factors was 0.22. The cooperation-related factor correlated 0.10 with impression management and 0.25 with self-deception, whereas the general factor correlated 0.48 with impression management and 0.05 with self-deception. These factors, thus, account for different facets of the tendency to respond in a desirable way.

(2) The participants were asked to estimate the social class they belonged to on a scale of five classes (from lower class to upper class), and the amount of money for weekly personal expenses. They could use seven classes (in Lire, £1000 = \$0.60): (1) 0–10,000; (2) 10,000–30,000; (3) 30,000–70,000; (4) 70,000–150,000; (5) 150,000–300,000; (6) 300,000–500,000; (7) over 500,000. The students could differ substantially in the amount of money they had at their disposal, since in Italy this depends heavily on family support. To our knowledge the third class includes the amount of money an average student receives each week from his or her family for personal expenses. Finally, three questions were included concerning: (a) the complexity of the experimental task, (b) the participants' belief that they had made a mistake in choosing their strategies, (c) whether the participants felt themselves forced by the experimenter to behave in a way other than they usually would. The variables were measured via 10-point scales (1 = not at all, 10 = completely).

RESULTS

Two out of 76 participants were excluded in the following analyses because they did not correctly answer the questions used to check the understanding of the PD.[8] In the PD, 41 participants (55.5%) defected and 33 participants (45.5%) cooperated. However, the experiment was set up such that 36 (48.6%) participants observed the opponent's strategy as defection and 38 (52.4%) as cooperation. The percentage of obtained cooperation is consistent with the value usually found in prisoner's dilemma (cf. Nemeth, 1970), and supports the idea that neither the experimental procedure nor the sample were idiosyncratic as regards the participants' behavior.

Hypotheses derived from the model

To test the hypotheses concerning the PD, we divided the sample in high-expectation of cooperation ($N = 38$) and low-expectation of cooperation ($N = 36$) and in high-lambda ($N = 40$) and low-lambda ($N = 34$) using the sample means as cut-off points.

[8] We performed all the analyses also considering these two participants. The results were the same.

Exhibit 3. Means proportion of cooperation by participant's lambda and expectation of opponent's cooperation

	Expected opponent's cooperation		
Participant's lambda	Low	High	Total
Low	0.00	0.41	0.20
	0.00 (17)	0.50 (17)	0.41 (34)
High	0.36	0.90	0.65
	0.49 (19)	0.30 (21)	0.48 (40)
Total	0.19	0.68	
	0.40 (36)	0.47 (38)	

Note. In the first row the means proportion of cooperation are reported, in the second row are standard deviations with the number of participants in parentheses.

We therefore performed a 2(expectations) $\times$ 2(lambda) ANOVA with the proportion of cooperation as the dependent variable. Mean proportions are shown in Exhibit 3. According to H1, expectation of cooperation has a significant effect on the proportion of cooperation in the PD ($F(1, 74) = 28.6$, $p < 0.01$). High expectations of cooperation lead to a higher proportion of cooperation. According to H2, the concern of reciprocity has a significant effect on the proportion of cooperation in the PD ($F(1, 74) = 23.20$, $p < 0.01$). High lambdas lead to higher proportion of cooperation. Moreover, according to H3, the highest proportion of cooperation results from the combination of the two moderators. A planned comparison among the proportion of cooperation for high lambda and high expectations of cooperation contrasted with all the other cells showed a significant difference in the hypothesized direction ($t(70) = -2.87$, $p < 0.01$). It is very remarkable that 91% of the participants who showed both necessary conditions for cooperating did actually cooperate. Considering that the model qualitatively predicts 0% of cooperation for three cells and 100% of cooperation in one cell, the model predicts *perfectly* about 80% of the choices in the PD. This result can rule out explanations based *only* on reactions to the other's behavior or explanations based *only* on individuals' orientation.

(H4) As regards evaluations, the pattern of results confirmed the related hypothesis (see Exhibit 4). Participants who cooperated had a significantly more positive evaluation of the opponent's cooperation ($F(1, 72) = 8.5$, $p < 0.01$) and a less positive evaluation of the opponent's defection ($F(1, 72) = 37.7$, $p < 0.001$) than defecting participants. Moreover, cooperating participants evaluated the opponent's cooperation better than defection (paired-sample t-test $(32) = 10.01$, $p < 0.001$). Also defecting participants evaluate the opponent's cooperation better than defection (paired-sample t-test $(40) = 2.03$, $p < 0.05$). It should be noted, however, that as predicted by our analysis the difference in the evaluations is greater for cooperating participants (18.8 versus 7.48) than for defecting participants (16.2 versus 14.2). In fact, under the model's assumptions, cooperating participants receive a greater utility from the other's cooperation both in terms of self-material utility and social-related utility. For defecting participants, on the other hand, the other's cooperation increases only the material unity. This discrepancy was confirmed by the present results.

To test the hypotheses derived from the model concerning DG, we performed a 2(participant's lambda) $\times$ 2(opponent's strategy) ANOVA with the amount of money given to the opponent (M_{op}) as the dependent variable. Exhibit 5 shows the M_{op} means for the different cells expressed as the percentage of the total payoff that the participant gave to the opponent. The ANOVA model explained a good percentage of variance ($R^2 = 0.48$). The main effect of the opponent's strategy was highly significant ($F(1, 70) = 52.06, p < 0.001$) and substantial ($\eta^2 = 0.40$). An inspection of the means shows that participants tend to reward the opponent who cooperated and to punish the opponent who defected. As expected, the main effect of the participant's lambda was not significant ($F(1, 70) = 0.37$

Exhibit 4. Means of the evaluations of the opponent's strategy. One-way ANOVA results

	Participant's strategy		
	Defect	Cooperate	F
Evaluation of cooperation	16.2 (4.47)	18.8 (2.87)	8.5*
Evaluation of defection	14.2 (3.98)	7.48 (5.14)	37.7*

Note. The evaluations range from 3 to 21, with higher scores indicating more positive evaluations. Standard deviations are in parentheses. All the F's have 1,72 degrees of freedom.*$p < 0.001$.

Exhibit 5. M_{op} means (in percentage to the total payoff) by participant's lambda and opponent's strategy

Participant's lambda	Opponent's strategy		
	Defect	Cooperate	Total
Low	18.2% 18.7% (18)	31.8% 22.8% (16)	24.21% 21.0% (34)
High	2.2% 9.5% (18)	43.0% 14.5% (22)	24.7% 24.0 (40)
Total	10.2% 16.7% (36)	38.3% 19.0% (38)	

Note. In the first row the means of M_{op} are reported, in the second row the standard deviations are the number of participants in parentheses.

n.s.). The interaction was significant $F(1, 70) = 11.94$, $p < 0.001$) and sufficiently substantial ($\eta^2 = 0.15$). The pattern of means shows that the influence of the other's strategy is stronger and more extreme for high-lambda than for low-lambda participants. Specifically, low-lambda participants were less dependent on the opponent's strategy, whereas high lambda were more punishing when the other defected and more rewarding when the other cooperated. These results highlight the relevance of previous behaviors in influencing participants' decisions and support the logic behind our model. We can now test specifically the hypotheses concerning the behavior in the DG.

(H5) The dictators faced with cooperating opponents in the PD showed a higher M_{op} than dictators faced with defecting opponents. Inspection of the means (Exhibit 5) shows a clear pattern in the hypothesized direction. On average, dictators reciprocated the opponent's PD cooperation by giving about 38% of the total payoff, whereas they reciprocated the opponent's PD defection by giving about 10%.

(H6) High-lambda dictators rewarded the opponent's cooperation with almost an equal share ($M_{op} = 43\%$), whereas low lambda rewarded the opponent's cooperation with lower values ($M_{op} = 31.08\%$). The planned comparison between the means showed a significant effect ($t(70) = 2.03$, $p < 0.05$).

(H7) High-lambda dictators punished the opponent's defection, giving almost zero to the opponent ($M_{op} = 2.2\%$). This pattern of behavior was also present for low-lambda dictators. However, consistent with the hypothesis that they were less influenced by the norm of reciprocity, they showed an attenuated behavior ($M_{op} = 18.2\%$). We tested the hypothesized differences between the variances in the two conditions (high-lambda dictators and low-lambda dictators, both faced with

Exhibit 6. Means of the participants' lambda and expectation of cooperation by the participants' strategy in the PD. One-way ANOVA results

	Participant's strategy		
	Defect	Cooperate	F
(a) Lambda (z-scores)	−0.374	0.454	14.76**
	(1.00)	(0.79)	
(b) Expectation of cooperation	2.98	4.64	23.7**
	(1.51)	(1.39)	

Note. The lambda measures are standardized. The expectations range from 0 (not likely) to 7 (very likely). All the F's have 1,72 degrees of freedom. ** = $p < 0.001$.

defecting opponents), using Levene's test for homogeneity of variances. The variances of the two groups were different (Levene's test $F = 18.14$, $p < 0.001$). In addition, the planned comparison between the means showed a significant effect ($t(70) = 2.85$, $p < 0.05$). Therefore, we can accept the hypothesis, since we have found both different variances and different means.[9]

(H8) A Levene test for the difference of the variances was performed. As predicted, the test was significant (Levene's test $F = 9.40$, $p < 0.01$), showing that in general low-lambda participants have a greater variance than high-lambda ones.

We now turn to the hypotheses concerning the link between the participants' choices in the PD and the DG. Exhibit 6 shows the characterization of the participants as a function of their strategy in the PD. As hypothesized, participants who cooperated in the PD showed a greater lambda and a higher expectation of other's cooperation.

To test the hypotheses derived from the model concerning the DG, we performed a 2(participant's strategy, C versus D) $\times$ 2(opponent's strategy, C versus D) ANOVA with the amount of money given to the opponent (M_{op}) as the dependent variable. Exhibit 7 shows the M_{op} means for the different cells. The results closely match the results obtained considering the explicit measure of lambda. As expected, the main effect of the participant's strategy was not sufficient ($F(1, 70) = 0.04$, n.s.), suggesting that the mere preference for cooperation or defection (or individual orientation) does not influence the behavior in the DG *irrespective* of the other's behavior. The interaction was significant $F(1, 70) = 12.95$, $p < 0.001$) and sufficiently substantial ($\eta^2 = 0.15$). As predicted, the equivalence between the measured lambda and the logically derived lambda was supported by the confirmation of all the following hypotheses.

(H9) Dictators who cooperated in the PD rewarded the opponent's cooperation with almost an equal share ($M_{op} = 45\%$), whereas dictators who defected in the PD rewarded the opponent's cooperation with lower values ($M_{op} = 30.4\%$). The planned comparison between the means showed a significant effect ($t(70) = 2.77$, $p < 0.01$).

(H10) Dictators who cooperated in the PD punished the opponent's defection, giving almost zero to the opponent ($M_{op} = 1.5\%$). Consistent with the results obtained with the empirical lambda, defecting dictators were less influenced by the norm of reciprocity ($M_{op} = 15.1\%$). The hypothesized differences between the variances in the two conditions (cooperating dictators and defecting dictators, both faced with defecting opponents) were significant (Levene's test $F = 35, 82$, $p < 0.001$). In addition, the planned comparison between the means showed a significant effect ($t(70) = 2.33$,

[9] Note that by showing that the variances are different, we are indicating that one of the statistical assumptions of the ANOVA (equal variances) is not achieved. However, the ANOVA is fairly robust against heteroscedasticity. Moreover, given the relation among cell size and variances size in our sample, the test should be more conservative (cf. Stevens, 1990, p. 42).

Exhibit 7. M_{op} means (in percentage to the total payoff) by participant's strategy and opponent's strategy

Participant's strategy	Opponent's strategy		
	Defect	Cooperate	Total
Defect	15.1%	30.4%	21.8%
	18.9% (23)	20.8% (18)	21.0% (41)
Cooperate	1.5%	45.0%	28.1%
	5.6% (13)	14.3% (20)	24.6% (33)
Total	10.2%	38.3%	
	16.7% (36)	19.0% (38)	

Note. In the first row the means of M_{op} are reported, in the second row are standard deviations with the number of subjects in parentheses.

$p < 0.05$). Therefore, we can accept the hypothesis, since different variances and different means were found.

(H11) The difference in variances between cooperating and defecting dictators facing a cooperating opponent were also significant (Levene's test $F = 7, 40$, $p < 0.001$), with defecting participants having a greater variance than cooperating ones.

(H12) The pattern is as predicted, both considering previous choices than values of lambda. With previous choices, the lowest amount of payoff is given after the combination C–D (1.5%), followed by D–D (15.1%), D–C (30.4%), and C–C (45.0%). As argued above, this pattern is unique to the reciprocity model and we do not see how it could be parsimoniously explained by using alternative models.

Finally, we consider the hypothesis suggested by an anonymous referee. The hypothesis concerns the sub-group of dictators who expected defection, defected in the PD and met an opponent who cooperated. The very small number of participants in this group ($N = 13$) does not allow a proper test of the hypothesis. However, we conducted an exploratory t-test for this sub-group, with M_{op} as a dependent variable and the evaluation of the defection as an independent variable (split around the mean). The results supported the hypothesis. Dictators who had a low evaluation of the opponent's defection gave a higher payoff ($M_{op} = 40\%$) to the opponent as compared with the dictators who had a high evaluation of the opponent's defection ($M_{op} = 23.8\%$). In spite of the very low number of participants, this difference was significant ($t(9{,}00) = 2.33$, $p < 0.05$, t-test with unequal variances). We also conducted a t-test for this sub-group, with M_{op} as the dependent variable and the participants' lambda as independent variables. Dictators who had a high lambda gave a higher payoff ($M_{op} = 38\%$) to the opponent who cooperated compared with the dictators with low lambda ($M_{op} = 18.5\%$). This difference was nearly significant ($t(8, 12) = 2.02$, $p = 0.07$, t-test with unequal variances), and in the suggested direction.

Additional analyses

We performed some additional analyses to assess the effects of influences among participants, characteristics of the sample of participants (gender, age, social class, personal income), social desirability of the response, and initial attitude towards the opponent. We checked also for the variables concerning the unwanted experimental features. These did not have any influence on the outcomes.

We computed the intra-class correlation (Haggard, 1958) for M_{op} to have an index of similarity among the participants who participated at the experiment in the same room. The coefficient was not

Exhibit 8. Regression coefficients for the alternative hypotheses variables on the M_{op}

Regression 1			Regression 2		
Variable	β	p	Variable	β	p
Age	−0.153	0.172	Imp. manag.	0.240	0.025
Gender	0.054	0.592	Self-deception	−0.040	0.682
Social class	−0.187	0.085	Cooperation SD	−0.001	0.996
Weekly money	0.097	0.387	General SD	0.013	0.901
Opp.'s strategy	0.642	0.000	Opp.'s strategy	0.603	0.000

Regression 3		
Variable	β	p
Overall evaluation of cooperation	−0.107	0.249
Opp.'s strategy	0.626	0.000

Note. Cooperation SD = Social desirability scale for cooperation. General SD = Social desirability in general. Opp.'s strategy = Opponent's strategy.

significantly different from zero ($r_{ic} = 0.01$, n.s.). To assess the possible influence of the characteristics of the participants on M_{op}, we performed a regression analysis with M_{op} as the dependent variable and age, gender, estimated social class, weekly available money. We included also the opponent's strategy as a predictor in the regression. In this way, we could assess either the direct influence of the variables to the DG behavior, and whether these possibly disturbing variables would change the relation between the DG behavior and the opponent's strategy. As shown in Exhibit 8, (regression 1), none of these variables produced a regression coefficient significantly different from zero, and the relation between M_{go} and the opponent's strategy was strong and significant.

We used the same methodology to test whether social desirability had an influence on DG behavior. Only the *impression management* scale showed a regression coefficient statistically different from zero (see Exhibit 8, regression 2). To understand its role, we repeated the analysis of variance participant's strategy × opponent's strategy with impression management as a covariate. The covariate did not produce any effect on the pattern of results. As regards the relation among the evaluation variables and M_{op}, regression analysis (Exhibit 8, regression 3) showed no influence of the evaluations on the behavior in the DG.

CONCLUSIONS

The results highlight the importance of previous interactions in influencing the individual's decision process. They support the influence of an internalized norm of reciprocity leading social actors to reciprocate, even when subjective benefits and costs may suggest a different behavior. The already acknowledged importance of reciprocity is further supported and qualified by the proposed model and the experimental results. Indeed, the model of reciprocity has been strongly supported by the experimental outcomes. Its predictions have been confirmed both using a logical and an empirical derivation, at a general and at a very specific level. Many hypotheses are uniquely derived from the model, and we do not see how they could have been derived otherwise. Finally, the uses of a symbolic approach allowed us to precisely test the model, over and above intuitive insights.

The results confirm the unique effects of reciprocity, compared with material self-interest or preference over equal outcomes. Individuals do not appear to strive to end up in a situation with an even outcome, but they do seem to react to the value of others' behavior, almost independently of their own past behavior. As we have shown, the most unfair outcome in the PD (Defect–Cooperate) *does not* lead to the highest reward in the DG. Even participants who dislike defection and defected as a consequence of their expectations do not give a higher payoff to the cooperating opponent than participants who cooperated in the PD game. The relation between previous and present choices appeared to be explained by a common cause (reciprocity), more than one being a consequence of the other.

This distinguishing feature of the proposed model has many theoretical implications. First, situational and individual characteristics as behavioral control over actions (Kelley and Thibaut, 1978), causal attribution and responsibility (Messick *et al.*, 1983; Rutte *et al.*, 1987) can be conveniently addressed using the model and may provide new and unexplored hypotheses.

Second, the proposed model provides a formal tool to link different conceptualizations of fairness, without abandoning the general assumptions of social utility models. As recent research in the field of justice has shown (Lind *et al.*, 1997), individuals' willingness to accept authorities and juries' deliberations rely mostly on how individuals have been treated by those institutions, namely on the procedural justice of the exchange. By incorporating the evaluation of others' behavior into the individual's utility function, it is possible to model preferences concerning how individuals are treated, their perception of the situation and their overall evaluation of the exchange. By the same argument, when behavioral valence strictly corresponds to material outcomes, reciprocal allocations turn out to be an implementation of distributive justice (Adams, 1965).

Third, recent work on cooperation in social dilemmas (Axelrod and Dion, 1988; Signorino, 1996) has emphasized how many situations are characterized by an imperfect link between intentions and behavior. This imperfect link is referred to as 'noise'. Our model provides a tool to distinguish between responses to uncontrolled behavior as mistakes or misperception of other's behavior and intentional behavior, independently of the actual outcomes obtained by individuals.

Notwithstanding the many virtues of the model of reciprocity, there is clearly potential for improvements. A basic point of the model is the introduction of the perceived valence of the others' behavior (*rho*). We have provided a general theoretical definition which allows for different implementations. Specific implementations may vary with the situational features and with the specific game. This flexibility, however, comes at the expense of a general solution.

One approach to develop a general solution is to describe the evaluation process using a function that maps the set of the opponent's strategy into the set of rho. Our definition of valence requires that the opponent's strategy should be evaluated by comparison with the other possible strategies. This approach resembles the one used by Rabin (1993) in defining the kindness of the players' strategies, where the opponent's strategy is judged as kind or unkind to the player in comparison with the other strategies available to the opponent. Whereas the specific solution proposed by Rabin is not applicable in many sequential games and it does not provide sound predictions in the reciprocity game, the basic idea is certainly sound. Indeed, there are an impressive number of studies in decision making showing the relevance of the frames in which the options are presented. However, so far no-one has proposed a general solution which would be robust enough to include a substantial variety of situations.

A second approach could be to measure directly the perceived valence of the others' behavior. This approach would skip at once the mathematical subtleties involved in the implementation. It would also be more accurate and likely to provide a better fit to experimental data. However, it would also restrict the applicability of the model to a narrower set of situations. Furthermore, this approach would not allow for a complete analysis of the situation *before* the measures are available. On the other hand, this approach could be particularly appealing when a thorough theoretical analysis is less important than an accurate prediction of the outcomes.

The model of reciprocity can also be extended, besides refining some of its basic features. The model can be paired with other mechanisms to study the interaction between these and the norm of reciprocity. For instance, it seems plausible that the strength of the reciprocity norm can be affected by whether the comparison implies a loss or a gain for participants (Kahneman, 1992; Tversky and Kahneman, 1991). Experimental evidence on the effects of patterning (Rachlin and Siegel, 1994; Silverstein *et al.*, 1998) would suggest that in iterated games individuals may reciprocate macro units of behavioral sequence instead of every single instance of opponents' behavior.

Even though scholars in social psychology and social decision making have widely advocated reciprocity as a basic social mechanism, detailed analyses of the consequences of this assumption have not often been reported. Our model is a step in pointing out that reciprocity does not only imply *copying* the others' behavior, but it implies articulated choices that depend on several individual and situational characteristics. Research is necessary to investigate these characteristics, and to further disentangle reciprocity from other factors underlying cooperation and social behavior.

A final remark concerns the very basic assumptions of our model as a social utility model. Do social utility functions represent truly unselfish motives? Is there any material convenience in abiding by a social norm? Our arguments claim that people follow the norm of reciprocity without external constraints or material benefits. At the same time, research (e.g. Axelrod, 1984) has shown that reciprocity can pay off in the long run. Are then reciprocators aware of this long-term convenience more than selfish individuals? Are they aware that reciprocal behavior is the best choice to gain in the future? Our results suggest that internal rewards (psychological utility) have an important role in motivating behavior even when future interactions are impossible or very unlikely.

Whether following an internalized social norm is a selfish act or not depends on the definition of selfish behavior. We have defined selfish or individualistic acts as aimed at maximizing material outcomes, and according to this definition reciprocity is certainly a social behavior. On the other hand, since pro-social behavior boosts future cooperation and in turn future rewards, reciprocity might be conceived as a trait that enhances rewards in the long term. More than solving a very difficult and perhaps insoluble question about whether reciprocity as an internalized norm is ultimately selfish or not, we believe it could be more interesting to turn our attention to when, how and in which way reciprocity influences behavior, for whom and with what consequences. We believe that our understanding of (economic) interactions will be much more advanced when we are able to substitute these qualifications with a list of specific conditions.

APPENDIX: ROBUSTNESS OF HYPOTHESES

In the following we show the robustness and generalizabilty of the theoretical analysis. In particular, we will show that the theoretical statements are robust for (1) the choice of the function F, representing the social-related utility, (2) the specific value of the received behavior (ρ_i) and (3) the analysis of the game as a two-stage game or as two different games.

We defined function F as function such that it has the maximum at $\pi_j = \rho_i$ and decreases as the difference between π_j and ρ_i increases. As regards the prisoner's dilemma, note that cooperation is the best reply to cooperation if $20 + \lambda_i F(20 - 20) > 25 + \lambda_i F(25 - 10)$. That is, if $\lambda_i > \lambda^*$ where

$$\lambda^* = \frac{5}{F(20 - 20) - F(25 - 10)} \tag{A1}$$

Given that, according to the definition of reciprocity, the utility is maximal when $\pi_j = \rho_i$, we have always that $F(20 - 20) > F(25 - 10)$ and thus the ratio in equation (5) is always positive and $\lambda^* > 0$. In other words, there is a feasible value of lambda such that cooperation is the best reply to cooperation. As regards defection, the same technique would show that defection is the best reply to defection. Summing up, the necessary and sufficient conditions for defection and cooperation hold regardless of the specific function *F*. Therefore, H1, H2 and H3 do not depend on the specific *F*. Naturally, they hold for every prisoner's dilemma irrespective of the payoffs. As regards H4, a simple inspection of Exhibit 2 clarifies that any function satisfying the requirements will converge to the same results obtained in the formal analysis. Exhibit 1 shows different utility functions with linear, i.e. $|\pi_j - \rho_i|$, convex, i.e. $(\pi_j - \rho_i)^2$, and concave, i.e. $\sqrt{|\pi_j - \rho_i|}$, *F* (for a given λ_i and ρ_i). The prediction of the model is given by the maximal utility, namely the peak of the curves. It is therefore clear that the predictions about the DG are the same for any of these functions.

The model's predictions about the behavior in the DG are robust against different specifications of the value of the received behavior (ρ_i). Since the best strategy for the dictator is

$$d^* = \rho_s - \frac{1}{2\lambda_1}$$

the hypotheses hold if $\rho_C > \rho_D$. Therefore, they hold for $\rho_C > 0 > \rho_D$. In fact,

$$d^*_C = \rho_C - \frac{1}{2\lambda_1} > d^*_D = \rho_D - \frac{1}{2\lambda_1} \text{ for any } \rho_C > \rho_D \tag{A2}$$

If it is assumed that $\rho_D \leqslant 0$ all the hypotheses concerning ρ_s will also hold. Therefore, we have shown that to fully exploit the formalism of the model it is sufficient to assume a positive or negative valence of ρ_i. It follows that the experimental hypotheses of this contribution are compatible with any particular empirical specification of ρ_i, provided that the assumed valence (positive or negative) is maintained.

We have analyzed the PD and the DG separately although we have defined them as two stages of a single game. It could be argued that our analysis is inconsistent. First, note that by definition the value of the received behavior is not affected by this distinction. Second, in the DG the strategy of player 1 depends only on the value of the received behavior (and on lambda, but it is irrelevant in this context). Third, note that assuming a unique game is equivalent to saying that player 1 will choose a single strategy prescribing a behavior in each game. Thus, under the model's assumptions, dictators will chose the strategy that maximizes the sum of the utilities in the DG and in the PD. But the sum of the utilities will be maximal when the two utilities are maximal, namely when the player is maximizing both in the PD and in the DG. It follows that player 1 will choose the strategy that maximizes the utility in each single game. We can conclude that, since we are focusing on player 1, considering the reciprocity game as a single two-stage game or as two games is irrelevant and therefore the postulates do not depend on this choice.

ACKNOWLEDGEMENTS

The authors wish to thank Dr Lars Persson (Faculty of Economics, University of Stockholm, Sweden) for stimulating discussions and useful suggestions about the model and the experimental procedure, and to express their gratitude to the editor and three anonymous reviewers for comments made on an earlier draft of this paper.

REFERENCES

Adams, J. S. 'Inequality in social exchange', in Berkowitz, L. (ed.), *Advances in Experimental Social Psychology*, Vol. 2 (pp. 267–29), New York: Acadmic Press, 1965.

Axelrod, R. *The Evolution of Cooperation*, New York: Basic Books, 1984.

Axelrod, R. and Dion, D. 'The further evolution of cooperation', *Science*, **242** (1988), 1385–90.

Benton, A. A., Kelley, H. H. and Liebling, B. 'Effects of extremity of offers and concession rate on the outcomes of bargaining', *Journal of Personality and Social Psychology*, **24** (1972), 73–83.

Berg, J., Dickhout, J. and McCabe, K. 'Trust, reciprocity and social history', *Games and Economic Behavior*, **10** (1995), 122–42.

Blau, P. *Exchange and Power in Social Life*, New York: Wiley, 1964.

Blount, S. 'When social outcomes aren't fair: the effect of causal attributions on preferences', *Organizational Behavior and Human Decision Processes*, **63** (1995), 131–44.

Bolton, G. E. 'A comparative model of bargaining: Theory and evidence', *American Economic Review*, **81** (1991), 1096–1136.

Bolton, G. E. and Ockenfels, A. 'ERC: A theory of equity, reciprocity and competition', *American Economic Review*, (1999, in press).

Cialdini, R. B. *Influence: Science and practice*, 2nd edn, Glenview, IL: Scott, Foresman, 1988.

Cialdini, R. B., Green, B. L. and Rusch, A. J. 'When tactical pronouncement of change becomes real change: the case of reciprocal persuasion', *Journal of Personality and Social Psychology*, **63** (1992), 30–40.

Conrath, D. W. and Deci, E. L. 'The determination and scaling of a bivariate utility function', *Behavioral Science*, **14** (1969), 316–27.

Dawes, R. M. and Thaler, R. H. 'Anomalies: cooperation', *Journal of Economic Perspectives*, **2** (1988), 187–97.

Esser, J. and Komorita, S. S. 'Reciprocity and concession making in bargaining', *Journal of Conflict Resolution*, **31** (1975), 864–72.

Fehr, E. and Schmidt, K. 'A theory of fairness, competition, and cooperation', *Quarterly Journal of Economics*, (1999, in press).

Fudenberg, D. and Tirole, J. *Game Theory*, Boston, MA: MIT Press, 1991.

Geanakoplos, J., Pearce, D. and Stacchetti, E. 'Psychological games and sequential rationality', *Games and Economic Behavior*, **1** (1989), 60–79.

Gouldner, A. W. 'The norm of reciprocity: A preliminary statement', *American Sociological Review*, **25** (1960), 161–78.

Guth, W. and Tietz, R. 'Ultimatum bargaining behavior: A survey and comparison of experimental results', *Journal of Economic Psychology*, **11** (1990), 417–99.

Haggard, E. A. *Intraclass Correlation and the Analysis of Variance*, New York: The Dryden Press, 1958.

Kahneman, D. 'Reference points, anchors, norms, and mixed feelings', *Organizational Behavior and Human Decision Processes*, **51** (1992), 296–312.

Kelley, H. H. and Thibaut, J. *Interpersonal Relations: A theory of interdependence*, New York: Wiley, 1978.

Kirchsteiger, G. 'The role of envy in ultimatum games', *Journal of Economic Behavior and Organization*, **25** (1994), 373–389.

Komorita, S. S. and Esser, J. 'Frequency of reciprocated concessions in bargaining', *Journal of Personality and Social Psychology*, **32** (1975), 699–705.

Komorita, S. S., Hilty, J. A. and Parks, C. D. 'Reciprocity and cooperation in social dilemmas', *Journal of Conflict Resolution*, **35** (1991), 494–518.

Komorita, S. S., Parks, C. D. and Hulbert, G. L. 'Reciprocity an the induction of cooperation in social dilemmas', *Journal of Personality and Social Psychology*, **62** (1992), 607–17.

Krebs, D. L. 'Empathy and altruism', *Journal of Personality and Social Psychology*, **32** (1975), 1134–46.

Larrick, R. P. and Blount, S. 'The claiming effect: Why players are more generous in social dilemma than in ultimatum games', *Journal of Personality and Social Psychology*, **72** (1997), 810–25.

Leventhal, G., Weiss, T. and Long, G. 'Equity, reciprocity and reallocating rewards in dyad', *Journal of Personality and Social Psychology*, **13** (1969), 300–05.

Liebrand, W. G. B., Wilke, H. A. M., Vogel, R. and Wolters, F. J. M. 'Value orientation and conformity: A study using three types of social dilemma games', *Journal of Conflict Resolution*, **30** (1986), 77–97.

Lind, E. A., Tyler, T. R. and Huo, Y. J. 'Procedural context and culture: Variation in the antecedents of procedural justice judgments', *Journal of Personality & Social Psychology*, **73** (1997), 767–80.

Loewenstein, G. F., Thompson, L. and Bazerman, M. H. 'Social utility and decision making in interpersonal context', *Journal of Personality and Social Psychology*, **57** (1989), 426–441.

MacCrimmon, K. R. and Messick, D. M. 'A framework for social motives', *Behavioral Science*, **21** (1976), 86–100.
McClintock, C. G. and Liebrand, W. B. G. 'Role of interdependence structure, individual value orientation, and other's strategy in social decision making: A transformational analysis', *Journal of Personality and Social Psychology*, **55** (1988), 396–409.
Messick, D. M. and McClintock, C. G. 'Motivational bases of choice in experimental games', *Journal of Experimental Social Psychology*, **4** (1968), 1–25.
Messick, D. M. and Sentis, K. P. 'Estimating social and nonsocial utility functions from ordinal data', *European Journal of Social Psychology*, **15** (1985), 389–399.
Messick, D. M., Wilke, H., Brewer, M. B., Kramer, R. M., Zemke, P. E. and Lui, L. 'Individual adaptations and structural change as solutions to social dilemmas', *Journal of Personality and Social Psychology*, **44** (1983), 294–309.
Nemeth, C. 'Bargaining and reciprocity', *Psychological Bulletin*, **74** (1970), 297–308.
Paulhus, D. L. 'Measurement and control of response bias', in Robinson, J., Shaver, P. R. and Wrightsman, L. (eds), *Measures of Personality and Social-Psychological Attitudes*, San Diego: Academic Press, 1990.
Perugini, M. and Gallucci, M. 'A game-theoretical model of the internalized norm of reciprocity', paper presented at the ESRC conference on Decision-making in theory and practice, stream 'Applications of Game Theory', Oxford, 2 July (1998).
Rabin, M. 'Incorporating fairness into game theory and economics', *American Economic Review*, **83** (1993), 1281–1302.
Rachlin, H. and Siegel, E. 'Temporal patterning in probalistic choice', *Organizational Behavior and Human Decision Processes*, **59** (1994), 161–76.
Rutte, C. G., Wilke, H. A. M. and Messick, D. M. 'Scarcity or abundance caused by people or the environment as determinants of behavior in the social dilemma', *Journal of Experimental Social Psychology*, **23** (1987), 208–16.
Signorino, C. S. 'Simulating international cooperation under uncertainty: The effects of symmetric and asymmetric noise', *Journal of Conflict Resolution*, **40** (1996), 152–205.
Silverstein, A., Cross, D., Brown, J. and Rachlin, H. 'Prior experience and patterning in a prisoner's dilemma game', *Journal of Behavioral Decision Making*, **11** (1998), 123–38.
Stevens, J. *Intermediate Statistics: A modern approach*, Hillsdale, NJ: Lawrence Erlbaum, 1990.
Surra, C. A. and Longstreth, M. 'Similarity of outcomes, interdependence, and conflict in dating relationships', *Journal of Personality and Social Psychology*, **59** (1990), 501–16.
Thibaut, J. and Kelley, H. H. *The Social Psychology of Groups*, New York: Wiley, 1959.
Thompson, L. and Loewenstein, G. F. 'Egocentric interpretations of fairness and interpersonal conflict', *Organizational Behavior and Human Decision Processes*, **51** (1992), 176–97.
Tversky, A. and Kahneman, D. 'Loss aversion in riskless choices: A references-dependent model', *Quarterly Journal of Economics*, **106** (1991), 1039–61.
Wilke, H. A. M. and Braspenning, J. 'Reciprocity: Choice shift in a social trap', *European Journal of Social Psychology*, **19** (1989), 317–26.
Wyer, R. S. 'Prediction of behavior in two-person games', *Journal of Personality and Social Psychology*, **13** (1969), 222–38.

Authors' biographies:
Marcello Gallucci is currently a graduate student at the University of Rome, Faculty of Psychology. His interests are in game theory, social dilemmas, psychometrics and personality.

Marco Perugini is a Lecturer in Psychology at the University of Leicester. He received his PhD from the University of Rome, Faculty of Psychology, in 1993. His interests are in social norms, game theory, personality, psychometrics and attitude.

Authors' addresses:
Marcello Gallucci, Department of Developmental and Social Psychology, Faculty of Psychology, University of Rome 'La Sapienza', Via dei Marsi 78, 00185, Rome, Italy.

Marco Perugini, Department of Psychology, University of Leicester, University Road, Leicester LE1 7RH, UK.

